PATENT SPECIFICATION

DRAWINGS ATTACHED

Inventor: ALAN SYDNEY DARLING

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COMPLETE SPECIFICATION

Improvements in and relating to the production of Composite Metallic Strip or Rod

We, JOHNSON, MATTHEY AND COMPANY LIMITED, a British Company, of 78, Hatton Garden, London, E.C.1, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to improvements in and relating to the production of composite bi-metallic or multi-layered metallic strip or rod.

Various methods are known for the production of composite strip or rod, the most usual method being to arrange strips of the two or more metals required in the finished article in superposed relation to one another and to pass the heated composite strip through rollers by means of which the two or more layers are intimately bonded to one another to form a unitary strip.

It is also known to form a metallic strip or rod by extrusion of a metallic billet through a die of the desired cross-section.

It has, moreover, been suggested to form a composite rod or wire by means of an extrusion procedure. By this procedure a rod or wire of one metal having a sheathing of another metal may be formed by extruding a composite billet formed of the two metals through a die in a single extrusion operation. Or, instead of a single composite billet, two superposed billets may be used, simultaneous extrusion being effected by a single ram through a die.

Whilst the methods above referred to basically achieve their intended purpose of providing a composite product, considerable difficulty is experienced, particularly in the case of billet extrusion, in attaining a satisfactory degree of uniformity of the two metallic layers throughout the extruded products, that is to say, the required uniform longitudinal and transverse distribution of the metals in the extruded product.

Various expedients have been suggested for overcoming this difficulty, ranging from the provision of a glass-like lubricant between the composite billet and the die and between the billet and the billet container, for the purpose of attaining longitudinal uniformity, to predetermined relative arrangements of the components of the composite billet.

Another method aimed at achieving both longitudinal and transverse uniformity of distribution of the metals in a composite rod or wire consists in extruding a coating metal through a die around a pre-formed wire or rod, which is preferably fed forward in the direction of extrusion through the die at a speed in conformity with the rate of extrusion of the coating metal.

The principal object of this invention is to provide an improved method of making bi-metallic or multi-layered metallic strip or rod, which is simple and efficient.

Another object is to provide a method of making bi-metallic or multi-layered metallic strip or rod by means of which unformity of distribution of the component metals throughout the length of the strip or rod is assured.

A further object is to enable bi-metallic or multi-layered metallic strip having uniform longitudinal and transverse distribution of the component metals throughout the strip to be obtained by an extrusion method.

According to the invention, there is provided a method of producing bi-metallic or multi-layered metallic strip or rod which comprises extruding two or more separate billets, each composed of a different metal or alloy from the other billet or billets, and each contained in a separate container, simultaneously through a common die, the volume of metal extruded from each billet being predetermined

[*Price 3s. 6d.*]

in accordance with the relative proportions of the metallic layers required in the extruded product.

It is to be understood that by the term "billet" as used herein and in the claims is meant either a solid metal billet or a pressed and sintered metal powder compact.

Each billet is preferably composed of only a single metal or alloy, the number of billets simultaneously extruded being determined by the number of layers required in the finished product.

Each billet is preferably extruded by an independently operated ram, the simultaneous extrusion of the requisite volumes of metal from the respective billets being obtained either by the use of billets of the same cross-sectional area and adjustment of the relative speeds of the rams as required, or by driving the rams at the same speed and using billets the relative cross-sectional areas of which have been predetermined as required. In the latter case, of course, the rams may, if desired, be actuated by a common operating mechanism.

The extrusion operation is advantageously carried out at a temperature such that the two or more metals or alloys being extruded become pressure welded together in the die and below that at which the formation of a liquid phase can arise due to interaction between the metallic components.

In carrying out the invention, the billets may be located in containers arranged, in parallel relation, vertically above or below the extrusion die and be extruded by vertically operating rams. Or, the containers may be arranged horizontally on one or on opposite sides of the die and horizontally moving rams be used. Or, again, if desired, a combination of these procedures may be employed, one or more of the billets being arranged vertically and the other billet or billets disposed horizontally with respect to the common die, extrusion being effected by independently operated vertically and horizontally moving rams.

By suitable choice of die, the invention may be applied to the production of ordinary continuous overlay or inlay extruded bi-metal or multi-layered metal sections or edge-lay sections. Where independently operated rams are used, discontinuous or "interrupted" multi-layered sections can, obviously, readily be obtained by the method of the invention.

Any suitable combination of metals or alloys may be used in carrying out the invention, such as are commonly employed in existing methods of making composite metal strip or rod. For example, combinations of silver-copper, silver-steel, silver-phosphor bronze, or silver-cadmium may be used. Any other suitable combination of base metals or alloys or of base metal and noble metal or alloys thereof may, however, be employed in carrying out the invention. The choice of suitable combinations is considered to be well within the capacity of persons skilled in the art and it is not therefore necessary to enumerate them here.

In order that the invention may be fully understood, one embodiment thereof, as applied to the production of silver-copper bi-metal strip, will now be described by way of example, by reference to the accompanying diagrammatic drawing, the single figure of which shows, in sectional side view, a double horizontal ram extrusion press suitable for carrying out the method of the invention.

Referring to the drawing, the extrusion press, generally designated by the reference numeral 1, comprises a pair of opposed cylinders 2 and 3, horizontally disposed on opposite sides of a die 4. Between each of the cylinders 2 and 3 and the die 4 is located a container denoted by the numerals 5 and 6 respectively, said containers having openings 7 and 8 respectively therein for the reception of billets to be extruded.

Slidable in the cylinders 2 and 3 are ram pistons, designated respectively by numerals 9 and 10, the ram extensions 11 and 12 of which are adapted to enter the openings 7 and 8 in the containers 5 and 6 during the extrusion operation. The ram pistons 9 and 10 are actuated in the direction of extrusion by the independently controlled introduction to the cylinders 2 and 3 of pressure fluid from a suitable source of supply (not shown) through inlet ports 13 and 14 respectively. 15 and 16 indicate further inlet ports for pressure fluid to effect the return movement of the rams 9 and 10.

The die passage comprises two convergent portions 4*a* and 4*b* which unite into a single outlet passage 4*c*.

In the case where the bi-metal strip to be extruded is to comprise two layers of different metals of equal thickness, the volume of each metal extruded will be the same, and the rams 9 and 10 will be simultaneously moved at the same speed and the pressure on both sides of the die 4 will be the same or substantially the same. However, when the relative volumes of metal to be extruded differ from one another, the necessary difference in the speed of the rams, coupled with the difference in hardness of the metal or alloy billets, will, however, in general cause the loads exerted by the two rams to differ to a considerable extent. In order to compensate for, or balance, this difference in pressure, the press 1 is provided with a slidable portion 17, actuatable by a pair of balancing rams 18 and adapted, during the extrusion operation, to exert pressure on the end of the container 6. With the billets so placed, that the greater load is always exerted by the ram 10, the unbalanced force on the die 4 will force this firmly against the end face of the container 5, ensuring a tight seal and preventing leakage of metal from the billet

19 between the die 4, and the container 5. The pressure exerted by the balancing rams 18 will seal the container 6 against the die 4.

In carrying out the method of the invention with the use of the above described press for the production of copper-silver bi-metal strip, comprising a basis layer of copper of predetermined thickness and a silver layer of lesser predetermined thickness, the rams 9 and 10 are first withdrawn away from the die 4 to the furthest extent of their stroke.

A preheated silver billet 19 is then placed in the opening 7 in the container 5 and a preheated copper billet 20 placed in the opening 8 in the container 6. Pressure is then applied simultaneously to the ram pistons 9 and 10, causing them to move towards the die 4, and the ram extensions 11 and 12 to enter the container openings 7 and 8 respectively. As will be understood, the relative speeds of the rams 9 and 10 are adjusted in accordance with the required relative volumes of metal to be simultaneously extruded. Continued movement of the rams 9 and 10 causes metal of the silver billet 19 to be extruded through the die passage 4 *a* whilst, at the same time, metal of the copper billet 20 is extruded through the die passage 4 *b*. The two extrusions thus converge and meet at the inner end of the die passage 4 *c*, to issue from the outlet end of the said passage 4 *c*, in the form of a continuous composite copper-silver overlay bi-metal strip, as indicated at 21 in the drawing.

The extrusion operation is carried out at a temperature such that the copper and silver layers beccme pressure welded together in the die passage 4 *c*. A metal temperature of the order of 750° C. will be found to produce an efficient weld.

In the above, the rams 9 and 10 have been stated to be independently controlled and driven at different speeds. In the example described, this is, of course, necessary as the billets 19 and 20 have the same cross-sectional areas. If desired, however, the container 6 may be modified so as to accommodate a billet of smaller cross-sectional area than the container 5, the relative cross-sectional areas of the billets being predetermined in accordance with the relative thickness of the metals required in the finished product. In this case, the two rams 9 and 10 will be driven at the same speed, and may, if desired, be controlled by a common control mechanism.

Although, in the above example, the production of an overlay bi-metal strip has been described, it will be understood that, by suitably modifying the extrusion die opening, inlay bi-metal strip, that is to say, strip in which one layer e.g. the silver layer lies in a channel formed in the other layer during extrusion may be obtained. Or, one of the metals may be extruded through two separate channels in the die so as to form two edge layers of one metal on the other extruded layer.

Moreover, by the addition of a further ram or rams, which may be horizontally or vertically operating as described, tri-metal or multi-layered metal strip or rod may readily be obtained by the method of the invention.

Furthermore, when independently operated rams are used, one or more of the rams may be operated intermittently whilst the other or others is/are continuously operated. By this means, strip composed of bi-metal sections spaced by single metal layer sections, or multi-layer metal sections spaced by bi-metal sections may be produced.

It is also to be understood that the invention is intended to include within its scope bi-metal or multi-layered metal strip or rod when made by the method of the invention.

WHAT WE CLAIM IS:—

1). A method of producing bi-metallic or multi-layered metallic strip or rod which comprises extruding two or more separate billets, each composed of a different metal or alloy from the other billet or billets and each contained in a separate container, simultaneously through a common die, the volume of metal extruded from each billet being predetermined in accordance with the relative proportions of the metallic layers required in the extruded product.

2). A method as claimed in Claim 1 wherein each billet is composed of a single metal or alloy only.

3). A method as claimed in either of the preceding claims wherein each billet is extruded by an independently operated ram.

4. A method as claimed in Claim 3, wherein the billets have the same cross-sectional area and the relative speeds of the rams are adjusted according to the predetermined volume of metal to be simultaneously extruded from the respective billets.

5). A method as claimed in Claim 3, wherein the rams are driven at the same speed, and the relative cross-sectional areas of the billets are such as to provide the required relative volumes of extruded metal.

6). A modification of the method claimed in Claim 5 wherein the rams are activated by a common operating mechanism.

7). A method as claimed in any of the preceding claims wherein the extrusion is carried out at a temperature such as to cause the two or more metals or alloys being extruded to become pressure welded together in the die.

8). A method as claimed in any of the preceding claims wherein the billets are arranged in vertically disposed containers located above or below the extrusion die and are extruded by vertically operating rams.

9). A method as claimed in any of the claims 1—7 wherein the billets are arranged in containers disposed horizontally on one or on opposite sides of the die and are extruded by horizontally moving rams.

10). A method as claimed in any of Claims

1—7 wherein a combination of both vertical and horizontal containers and associated vertically and horizontally operating rams is employed.

11). The improved method of producing bi-metallic or multi-layered metallic strip or rod substantially as hereinbefore described.

12). The method of making copper-silver bi-metal strip substantially as hereinbefore described with reference to the accompanying drawing.

13). Bi-metallic or multi-layered metallic strip or rod when made by the method claimed in any of claims 1—11.

14). Copper-silver bi-metal strip when made by the method claimed in claim 12.

CHARLES K. REDFERN,
78, Hatton Garden, London, E.C.1.
Chartered Patent Agent,
Agent for Applicants.

PROVISIONAL SPECIFICATION

Improvements in and relating to the production of Composite Metallic Strip or Rod

We, JOHNSON, MATTHEY & COMPANY LIMITED, a British Company of 78 Hatton Garden, London, E.C.1, do hereby declare this invention to be described in the following statement:—

This invention relates to improvements in and relating to the production of composite bi-metallic or multi-layered metallic strip or rod.

Various methods are known for the production of composite strip or rod, the must usual method being to arrange strips of the two or more metals required in the finished article in superposed relation to one another and to pass the heated composite strip through rollers by means of which the two or more layers are intimately bonded to one another to form a unitary strip.

It is also known to form a metallic strip or rod by extrusion of a metallic billet through a die of the desired cross-section.

It has, moreover, been suggested to form a composite rod or wire by means of an extrusion procedure. By this procedure a rod or wire of one metal having a sheathing of another metal may be formed by extruding a composite billet formed of the two metals through a die in a single extrusion operation. Or, instead of a single composite billet, two superposed billets may be used, simultaneous extrusion being effected by a single ram through a die.

Whilst the methods above referred to basically achieve their intended purpose of providing a composite product, considerable difficulty is experienced, particularly in the case of billet extrusion, in attaining a satisfactory degree of uniformity of the two metallic layers throughout the extruded products, that is to say, the required uniform longitudinal and transverse distribution of the metals in the extruded product.

Various expedients have been suggested for overcoming this difficulty, ranging from the provision of a glass-like lubricant between the composite billet and the die and between the billet and the billet container, for the purpose of attaining longitudinal uniformity, to predetermined relative arrangement of the components of the composite billet.

Another method aimed at achieving both longitudinal and transverse uniformity of distribution of the metals in a composite rod or wire consists in extruding a coating metal through a die around a preformed wire or rod, which is preferably fed forward in the direction of extrusion through the die at a speed in conformity with the rate of extrusion of the coating metal.

The principal object of this invention is to provide an improved method of making bi-metallic or multi-layered metallic strip or rod, which is simple and efficient.

Another object is to provide a method of making bi-metallic or multi layered metallic strip or rod by means of which uniformity of distribution of the component means throughout the length of the strip or rod is assured.

A further object is to enable bi-metallic or multi-layered metallic strip having uniform longitudinal and transverse distribution of the component metals throughout the strip to be obtained by an extrusion method.

According to the invention, a method of producing bi-metallic or multi-layered metallic strip or rod comprises extruding two or more separate billets simultaneously through a common die at the same speed, the cross-sectional areas of the billets being predetermined in accordance with the relative proportions of the metallic layers required in the extruded product.

Each billet is preferably composed of only a single metal or alloy, the number of billets simultaneously extruded being determined by the number of layers required in the finished section.

Extrusion of the billets should preferably be carried out at such a temperature that the two or more metals or alloys become pressure welded together in the die and below that at which the formation of a liquid phase can arise due to interaction between the metallic components.

In carrying out the invention, each billet may be extruded by an independently operated ram, the said rams being driven at the same speed. If desired, however, the rams

may be actuated by a common operating mechanism.

The billets are advantageously located in containers arranged in parallel relation vertically above the extrusion die and are extruded by vertically operating rams. Or, one or more of the billets may be so arranged and the other billet or other billets may be disposed horizontally with respect to the die and be extruded by a horizontally moving ram or rams operated independently of the vertical ram or rams.

By suitably modifying the bore of the common extrusion die, ordinary continuous overlay or inlay extruded bi-metal sections, or edge-lay sections may be obtained. By the use of independently operated extrusion rams, discontinuous or "interrupted" multi-metal sections can also be readily obtained by the method of the invention.

Any suitable combination of metals or alloys may be used in carrying out the invention, such as are commonly employed in existing methods of making composite metal strip or rod. For example, combinations of silver-copper, silver-steel, silver-phosphor bronze, silver-cadmium may be used. Any other suitable combination of base metals or alloys or of base metal and noble metal or alloys thereof may, however, be employed in carrying out the invention. The choice of suitable combinations is considered to be well within the skill of persons skilled in the art and it is not thought necessary to enumerate them here.

In carrying out the invention in practice, according to a preferred embodiment for the production of copper-silver bi-metal strip, a copper billet and a silver billet, the relative cross-sectional areas of which are predetermined in accordance with the relative proportions of the copper and silver layers required in the finished strip are placed in vertical containers arranged side by side above a common extrusion die. Associated with each container is a ram adapted to apply pressure to the billet in its pertaining container so as to extrude the metal of the billet through the die. The two rams are actuated by a common driving mechanism so that, in operation, both rams are moved simultaneously at the same speed.

The copper and silver billets are thus simultaneously extruded at the same speed through the common die, to produce a copper-silver over-lay bi-metal strip, the two component layers of which are intimately bonded to one another throughout the length of the strip, the copper and silver being uniformly distributed in the required relative proportion throughout.

By suitably constructing the extrusion die opening, the extruded silver layer may be caused to lie in a channel formed in the copper layer during extrusion thereof, whereby an inlay bi-metal strip may be obtained.

Or, the silver billet may be extruded through two separate channels in the die so as to form two edge layers of silver on the extruded copper layer.

Whilst in the above, the rams have been described as being operated by a common driving mechanism, it will be understood that each ram may be independently operated, it only being necessary to ensure that they are driven synchronously and at the same speed.

The use of independently operated rams, moreover, has the advantage that one or more of the rams may be operated intermittently, whilst the other or others is/are continuously operated, whereby strip composed of bi-metal sections spaced by single metal layer sections or multi-metal sections spaced by bi-metal sections can readily be obtained.

It is to be understood that the invention is intended to include within its scope bi-metal or multi-metal strip or rod when made by the method of the invention.

CHARLES K. REDFERN,
Chartered Patent Agent,
78 Hatton Garden, London, E.C.1.
Agent for Applicants.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*